COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING QUADRUPLED HAMSTRING GRAFT FIXED WITH BIOABSORBABLE INTERFERENCE SCREW AGAINST TITANIUM INTERFERENCE SCREW

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CERTIFICATE

This is to certify that this dissertation in "**COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING QUADRUPLED HAMSTRING GRAFT FIXED WITH BIOABSORBABLE INTERFERENCE SCREW AGAINST TITANIUM INTERFERENCE SCREW**" is a bonafide work done by **DR.R.AGNIRAJ** under my guidance during the period 2012 – 2014. This has been submitted in partial fulfilment of the award of **M.S.** Degree in **Orthopaedics Surgery (Branch-II)** by The Tamilnadu Dr.M.G.R.Medical University, Chennai.

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DECLARATION

I, **Dr. R.AGNIRAJ,** solemnly declare that the dissertation titled "**COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING QUADRUPLED HAMSTRING GRAFT FIXED WITH BIOABSORBABLE INTERFERENCE SCREW AGAINST TITANIUM INTERFERENCE SCREW"** was done by me at The Rajiv Gandhi Government General Hospital, Chennai – 3, during 2010-2013 under the guidance of my unit chief **Prof. M.R.RAJASEKAR,M.S(Ortho), D.Ortho** The dissertation is submitted in partial fulfilment of requirement for the award of M.S. Degree (Branch - II) in Orthopaedic Surgery to **THE TAMIL NADU DR.M.G.R.MEDICAL UNIVERSITY.**

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CONTENTS

COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING QUADRUPLED HAMSTRING GRAFT FIXED WITH BIOABSORBABLE INTERFERENCE SCREW AGAINST TITANIUM INTERFERENCE SCREW

ABSTRACT

INTRODUCTION: Knee injuries are more common in the modern era due to increase in road traffic accidents and more involvement in sports related activities by common people. Anterior cruciate ligament is the most commonly injured ligament around knee joint. Anterior cruciate ligament has a pivot role in function and stability of the knee joint, being the primary stabilizer preventing the anterior translation of tibia over femur. Arthroscopic anterior cruciate ligament reconstruction has become the gold standard in the management of these injuries.

AIM OF THE STUDY: To do comparative analysis of the functional outcome of Arthroscopic anterior cruciate ligament reconstruction using quadrupled hamstring graft with endobutton as femoral fixation device and bioabsorbable interference screw against titanium interference screw as tibial fixation devices respectively.

MATERIALS & METHODS: This study is a retrospective and prospective study of 60 patients treated with arthroscopic anterior cruciate ligament reconstruction with quadrupled hamstring graft with endobutton as the femoral fixation device and titanium interference screw (no=30) and bioabsorbable interference screw (no=30) as tibial fixation device respectively between May 2012 and November 2013 at Institute of orthopaedics and traumatology, Rajiv Gandhi government general hospital, Chennai. Minimum age of the patient was 20 years and maximum age was 55 years with mean age of 31. Study group included 51 male patients and 9 female patients. Minimum duration after injury was 5 weeks and maximum duration since injury was 15 months. Minimum period of follow up was 6 months and maximum was 1.5 years. Of the 60 patients, 30 patients underwent arthroscopic assisted anterior cruciate ligament reconstruction with quadrupled hamstring graft with endobutton as femoral fixation device and tiatanium interference screw as tibial fixation device. Remaining 30 patients underwent arthroscopic assisted anterior cruciate ligament reconstruction with quadrupled hamstring graft with endobutton as femoral fixation device and bioabsorbable interference screw as tibial fixation device. All patients were operated under spinal aneasthesia. Except for 2 patients, postopearative period was uneventful for others.

RESULTS: All patients are evaluated with Lysholm and Gillquist scoring at the end of 6 months. The maximum score achieved was 100 and minimum score was 56. Two patients in titanium interference group and one patient in bioabsorbable interference screw group lost to followup. Statistical analysis was studied using Yate's corrected Chi-Square test. No significant differences were identified between the two screw typeswith respect to Lysholm and Gillquist scoring. The complication rates were also similar in the two groups.

CONCLUSION: The clinical results associated with titanium interference screw and bioabsorbable interference screw are statistically similar. The complication rates associated with the two screws were also similar. The results of this comparative analysis support the hypothesis that there are no significant differences in the outcomes associated with tiaanium screws compared with bioabsorbable screws for ACL reconstruction.

KEY WORDS: Anterior cruciate ligament, quadrupled hamstring graft, titanium, bioabsorbable, interference screw, endobutton, arthroscopy.

INTRODUCTION

INTRODUCTION

Knee injuries are more common due to exponential increase in road traffic accidents and more involvement in sports related activities by common people. Today, there is an ongoing debate among orthopaedic surgeons regarding the optimal treatment for knee injuries.

Anterior cruciate ligament injury is one of the most common injuries[(1)] around knee and poses quiet a lot management controversies. Anterior cruciate ligament has a pivot role in function and stability of the knee joint along with all other ligaments, being a prime stabilizer preventing the anterior translation of tibia over femur[(2)].Along with this function anterior cruciate ligament also restricts valgus and rotational stress to some extent.

Acute anterior cruciate ligament injury causes recurrent episodes of instability, pain and decreased motion. Anterior cruciate ligament injury is associated with meniscal injury and early onset of osteoarthritis [(3)]. There is also an involuntary decrease in function and activity of anterior cruciate ligament deficient knee. Anterior cruciate ligament reconstruction allows return to pre injury levels even in athletes, delays development of early osteoarthritis [(3)] and reestablish the stability of the joint [(4)].

Earlier extra articular procedures and intra articular reconstructions by open arthrotomy were done but complications like postsurgical knee stiffness and prolonged duration of rehabilitation has made reconstruction of ACL using Arthoscopic assisted method the treatment of the choice[(5)]. Decreased post-operative inflammation and possibility of early full range of movements makes arthroscopic reconstruction superior and more preferable than open procedures.

Nowadays, usage of soft tissue grafts is increasing in number than bone patellar tendon bone graft. Graft fixation during ACL reconstruction can be achieved with use of either metal screws or bioabsorbable screws. Bioabsorbable screws usage provide better visibility in postoperative MRI and also avoid removal at later stage. However there are controversies regarding the ideal graft, ideal fixation device, ideal time and technique of reconstruction.

AIM

AIM

To do comparative analysis of the functional outcome of Arthroscopic Anterior Cruciate Ligament Reconstruction using quadrupled hamstring graft with endobutton as femoral fixation device and bioabsorbable interference screw against titanium interference screw as tibial fixation devices respectively..

REVIEW

OF

LITERATURE

REVIEW OF LITERATURE

The high number of ACL injuries is a growing problem with serious consequences for the patient and society. An acute ACL injury is seldom isolated (15%), and is usually associated with concomitant injuries to the menisci (60%), cartilage (20%) and collateral ligaments.

True nature of anterior cruciate ligament was put forth by Galen in Circa 170 AD[6].In 1845 Amedee Bonnet described the essential signs of ACL tear as “In patients who have not suffered a fracture,a snapping noise, haemarthosis and loss of function are characteristic of ligamentous injury in the knee”[7]. Stark was the first surgeon to record the description of rupture of the cruciates in 1850.

In 1879 Paul F Segond wrote on his research in to knee effusions and described a avulsion fracture of anterolateral margin of tibia associated with ACL ruptures [8].

A.W.Mayo Robson performed the first cruciate ligament repair in 1895 which he failed to report in literature. Meanwhile in 1900 Brit, W.H.Battle exhibited a ACL repair in clinical society of London. In 1918 Alwyn Smith reconstructed ACL using silk substitute[9].

In 1936 Bosworth reported extra articular reconstruction using facia lata graft. In 1939 Henry B Macey first described the technique using semitentinosus graft.

D.L.MacIntosh familiarized extra articular reconstruction using fascia lata by various techniques in 1972.In 1976 Joseph S Torg student of John Lachman described the Lachmans test.Subsequently ACL reconstruction with free bone patellar tendon bone graft called as Jones procedure was very widely used and became gold standard.

In 1982 AB Lipscomb started using semitendinosus and gracilis soft issue grafts.In 1987 Kurosaka showed that the weakest link in the reconstruction was the fixation site atleast until the graft heals[10]. This led to discovery of various fixation device like cross pins, interference screws, soft tissue washers etc., and the endurance of these devices are studied since then.1988 MJ Freidman[11] pioneered use of four stranded hamstring in arthroscopic assisted technique.In 1992 Tom Roseberg[12] devised Endobutton as fixation device for ACL reconstruction.

Clancy, Ray et al in 1988 compared the conservative treatment of ACL injuries with surgical treatment and found that the surgical treatment was far superior in producing functional results. Barrack in 1990

concluded that young atheletes can only expect unsatisfactory results after conservative treatment of ACL rupture.

Lee in 1988 and Fischer,Fox in 1991 reported the sensitivity of MRI in diagnosing ACL tears and the high sensitivity and specificity of MRI has made it the most important noninvasive diagnostic tool in knee injuries.

Howell and Clark recommended more posterior placement of tibial tunnel(2-3mm) to the tibial foot print to avoid impingement.In 1992 Beynnon studied the usefulness of knee braces and recommended the use of knee braces post operatively for six months to protect the graft. In 1991 Shelbourne[13] recommended three weeks delay in reconstruction after injury and reported higher incidence of arthrofibrosis in knees with ACL reconstructed earlier following injury.

Though Arthroscopic intra articular reconstruction has become gold standard in ACL reconstruction in this century there is still debate regarding the choice of graft, fixation methods, single or double bundle and trans portal or trans tibial technique.

More recent studies have proved quadrupled Hamstring is superior in strength[14] but time for healing, probable loss of strength during healing and minimal hamstring weakness post operatively are

considerations. Though bone patellar tendon bone graft has theoretical advantage of bone to bone healing the limitation of size and strength of the graft, incidence of quadriceps weakness and anterior knee pain are considerable[15].

Recent studies have proved endobutton and bone mulch screw have a very high yield load than any other fixation device in view of soft tissue graft fixation[16]. The trans portal technique has been widely used nowadays but the trans tibial technique is easily reproducible and gives comparable functional outcomes though tunnel placement is not more accurate in trans tibial technique [17].

Bioabsorbable implants in orthopaedic surgery was introduced by Rokkanan et al and bostman et al for use in surgery of the ankle[18]. In 1987, Kurosaka introduced the current concepts of interference screw fixation[19]

ANATOMY

&

FUNCTION

ANATOMY & FUNCTION

EMBRYOLOGY

The knee joint starts to form from mesenchymal bud by fourth week of gestation. It is very quick that a recognizable joint is formed by sixth week. The anterior cruciate ligament appears early by 6.5 weeks[(20)]. It begins ventrally and gradually invaginates with the formation of the intercondylar space. It appears before joint cavity formation and remains extrasynovial at all times. There are very megre changes in ACL but it does migrate posteriorly. The fact that the cruciate ligaments and meniscus are derived from the same blastoma correlate with the theory that these structures function in concert.

ANATOMY

Anterior cruciate ligament is a strong extra synovial ligament but it is intra articular. It has a multi fascicular structure which runs from anterior part of the tibia posteriorly and laterally to the medial aspect of lateral femoral condyle. The ligament is 31 to 35 mm in length and 31.3 mm^2 in cross section.

It has two bundles

- Anteromedial bundle
- Posterolateral bundle lying deep to the former

FEMORAL ATTACHMENT

The anterior cruciate ligament gets attached in the medial aspect of lateral femoral condyle well posteriorly but around 15 mm anterior to the posterior cortex of the lateral femoral condyle[21].The posterior part of the ligament is seperated from the intermuscular septum by the posterior capsule

1) Anteromedial bundle attaches posteriorly and superiorly over the lateral condyle.

2) Posterolateral bundle attaches anteriorly and inferiorly over the lateral condyle.

On a notch view of the knee joint, the entire femoral attachment of the ACL is lateral to the midline of the intercondylar notch and occupies the superior 66% of the notch. It is from just inferior to the postero superior quadrant of the lateral femoral condyle. The center of the femoral tunnel for ACL reconstruction is between the 10 and 11 o'clock (right knee) or 1 and 2 o'clock (left knee) positions.

Tibial Attachment

The tibial attachment is a large area of around 23mm in the anterior tibial plateau anterolateral to the anterior tibial spine and medial to the attachment of anterior horn of lateral meniscus

1. The anteromedial band inserts on the medial surface of the intercondylar eminence.

2. The posterolateral band attaches lateral to the midline of the eminence.

The width of ACL averages 11.1 mm , length 31 to 38 mm.ACL consist of longitudinally oriented fascicles, a different portion of which is taut throughout the range of motion.

The important concepts of the normal ACL are that each fibre has a unique origin and insertion and that all fibres are not parallel and not of the same length and that do not have the same tension at any one point. The anteromedial bundle becomes taut in flexion and the posterolateral bundle becomes taut in full extension.

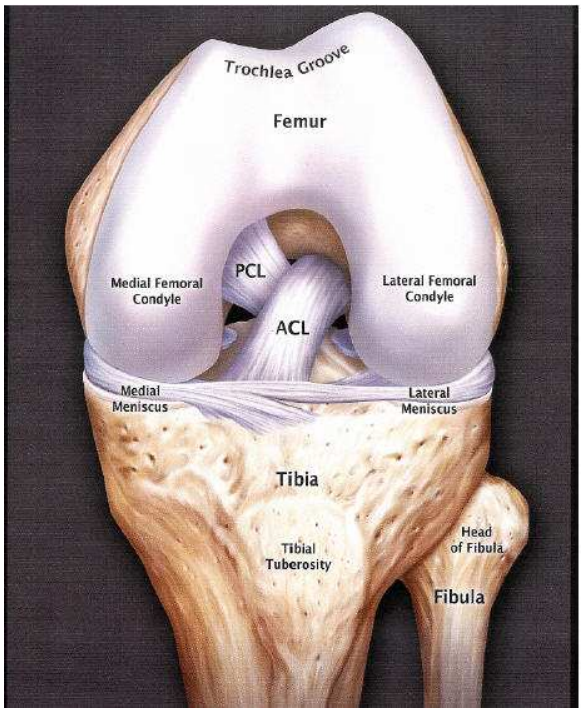


Figure 1: Anatomy of ACL

HISTOLOGY [22]

The ACL is made up of multiple fascicles, which are surrounded by connective tissue called the paratenon. Each fascicle ranges from several micrometers to several millimeters and consists of multiple sub-fasciculi, which are enclosed by an epitenon. The subfasciculi appear to have an undulating course, arranged in various directions. They consist of groups of sub fascicular units (100 – 250 μm in diameter), which are composed of fibers (1 – 20 μm in diameter) and surrounded by loose connective tissues, the endotenon. Each fiber is made up of collagen fibrils and interlace to form complex networks.Cells and elastic components account for 6% of all ACL tissue. Elastic and oxytalan fibers can be found distributed along the individual bundles.

BLOOD SUPPLY [23]

The blood supply of the ligament is by branches of middle genicular artery that enters through the intercondylar notch near the femoral attachment.The tibial site is supplied by the branches from the patellar pad of fat which is from the medial and lateral inferior geniculate artery.

There is little or no blood supply to ACL from its bony attachments. In spite of the above sources of blood supply, ACL receives its predominant supply by diffusion from synovial fluid.

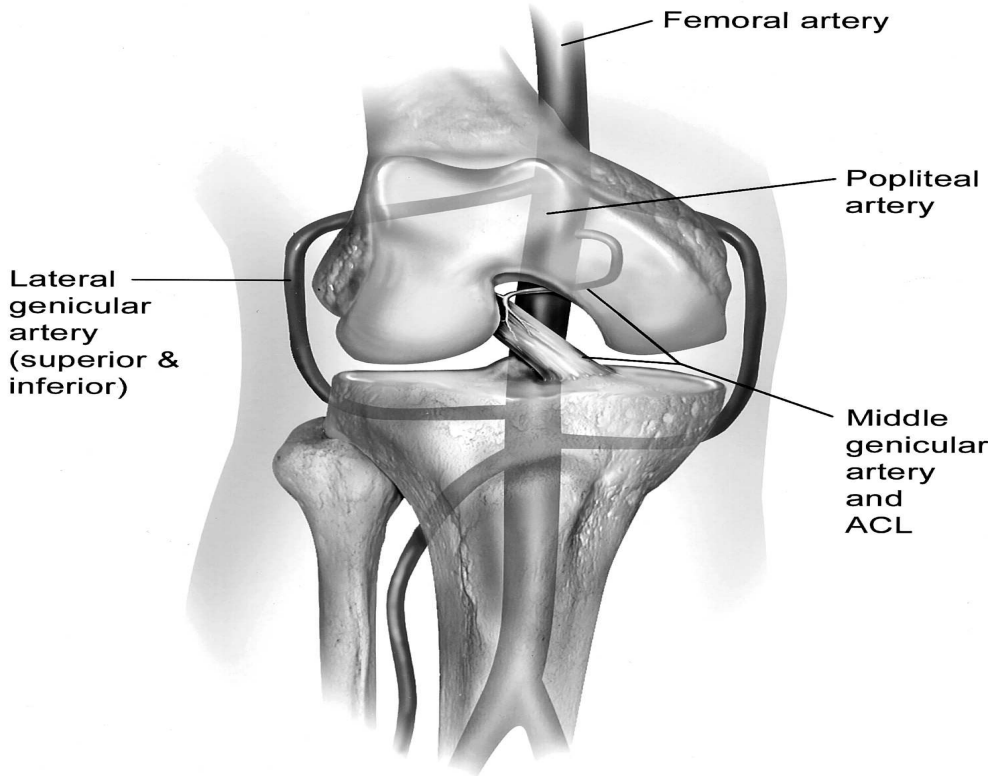


Figure 2: Blood Supply of ACL

NERVE SUPPLY AND NEURAL RECEPTORS[24]

Posterior articular nerve, branch of posterior tibial nerve innervates the anterior cruciate ligament. Most neural structures have been found in the subsynovial layer and near the insertions of the ACL. Histologic studies have demostrated nerves of sizes consistent with transmitting pain in the intrafasicular spaces. Mechanoreceptors are also identified in the surface of the ligament mostly near the femoral attachment site. The receptors found are primarily ruffini receptors and free nerve-endings that are thought to function as stretch receptors and nociceptors, respectively.

FUNCTION [25]

Anterior cruciate ligament along with other intra articular and extra articular ligaments, functions in maintaining static and dynamic equlibrium of the knee joint.

The prime function of the anterior cruciate is restraining the anterior movement of tibia over femur. The anteromedial bundle is taut in flexion and is the prime restraint to anterior drawer in 90 degree flexion accounting for about 85% resistance. The bulky posterolateral bundle

which becomes taut in extension provides principle resistance for hyperextension.

From the extensive histologic research and studies which had demonstrated receptors and free nerve endings in ACL there are evidence for proprioceptive function of the ACL.

BIOMECHANICS

The cruciate ligaments form the pivot and nucleus of the knee joint kinematics. On internal rotation the cruciates twist around each other and in external rotation they unwind. The anterior cruciate ligament exerts visco elastic properties like any other ligaments with its ultimate strength of 1725+/-269 N[(26)].

The range of mobility is enhanced by the orientation of fibers. Since the femoral origin of the cruciate ligaments lie on a line, it produces normal mobility of 5-0-145 degrees.

The anteromedial fibers of anterior cruciate ligaments are tense principally in flexion while the posterolateral fibers are in increasing tension as the knee is extended. The reciprocal relationship of this bundle constitutes a twist within the anatomy of this single ligament and provides for stability throughout the entire arc of knee motion assisting the rolling and gliding movement of the femoral condyle over the tibial plateau in the sagittal plane. Anterior cruciate ligament also assist in the screw home movement of the femoral condyle in the terminal extension.

In ACL tear, the femur rolls up onto the meniscus and its posterior horn on flexion and skids back. This causes meniscus symptoms and further tears[(27)]

MECHANISM OF INJURY

Knee joint is inherently unstable without the strong capsulo ligamentous structures supporting the joint in extension and flexion. Varus and valgus stability is provided by the medial and lateral structures along with cruciates. The cruciate ligaments provide anteroposterior and rotatory stability along with other capsuloligamentous structures. Depending on the position of the knee some acts as primary stabiliser and some as secondary stabiliser. Most ligamentous injuries occur with flexed knee when the capsule and ligaments are relaxed and femur is allowed to rotate on the tibia.

The commonest mechanism of injury is a non-contact deceleration with a valgus and twisting movement[(28).] In isolated ACL injury the mechanism of injury was mostly deceleration, internal or external rotation and hyperextension as with landing from a jump or sudden turning of direction while running.

Valgus movements do not cause a serious injury until medial collateral ligament is intact, but once it is injured the ACL ruptures as the valgus thrust continues. When this is associated with a rotational component the medial meniscus is torn caught between the articulating condyles causing the classical unhappy triad of O'Donoghue.

Regarding rotatory violence, on continued extension of the knee from flexion the femur rotates medially on tibia or tibia rotates externally to lock the knee which is called as screw home mechanism. On sudden block to screw home mechanism the ACL goes for stress and ruptures.

Also a direct posterior thrust on femur on fixed tibia as in dash board injury can cause avulsion injury of ACL especially in young individuals.

Various intrinsic and extrinsic factors are identified contributing to the anterior cruciate ligament tear. The intrinsic factors include factors which cannot be changed like the size of the ligament, notch width, physiological alignment of the joint and physiological laxity, hormonal influences, inherited skills and coordination. The extrinsic factors are those that can be modified like strength, conditioning and motivation. Many factors like coordination, proprioception, position sense and balance require both intrinsic and extrinsic factors. The most important factor contributing to ACL tear is the dynamic movement pattern rather than the static anatomic measurements.

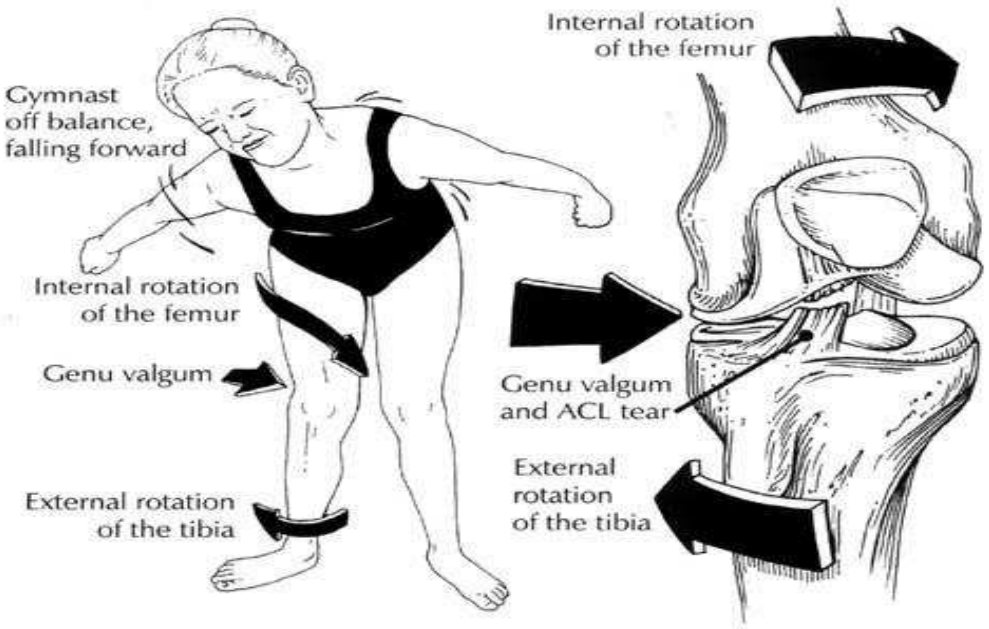


Figure 3: Mechanism of ACL injury

NATURAL HISTORY[28]

The course that an anterior cruciate ligament deficient knee follows or the natural history of anterior cruciate ligament tear is varied and there are many controversies regarding this, as all ACL tears are not reported, not all ACL injuries are symptomatic, and due to varied patient requirements and extent of injury. But it is very well documented that a ACL deficient athlete with a unstable knee will acquire a meniscal tear and arthrosis if he continues to involve in high demand activities in spite of repeated episodes of instability. It has been reported that around 50 to 70% of ACL injuries are associated with meniscus injury. Studies reveal that around 58 to 61 % of ACL injuries will require a meniscal surgery

within 5 years[29]. The incidence of chondral damage is reported to be twice in the chronic ACL tears than the acute tears.

Most patients are comfortable with their daily activities and have limitations only in vigorous sports. Only a few patients are purely asymptomatic. The persons with high pre injury activities like children, athletes are the persons most affected. It is the challenge to the surgeon and his responsibility to evaluate, understand and predict how an ACL injury will affect different individuals based on their requirement. The events following the anterior cruciate ligament injury is described as ACL cascade.

ACL CASCADE

ACL INJURY

↓

JOINT SUBLUXATION

↓

MENISCAL TEAR

↓

JOINT ARTHROSIS

CLINICAL EVALUATION

CLINICAL EVALUATION

PATIENT HISTORY

A good clinical examination of ACL injured patient starts with a good history taking. A twisting injury to the knee is usually the most common history. An audible pop during the injury, inability to walk after the injury and swelling of the knee joint over few hours are suggestive of anterior cruciate ligament tear. With the associated heamarthrosis the possibility of ACL tear is around 70%. Pain and sense of giving way of the knee joint are the usual symptoms at the presentation. Non-contact injuries are commonly associated with ACL tear while contact injuries are commonly associated with multi ligament injuries. With valgus violence and internal rotation injury the medial structures and collaterals are initially disrupted and with continued violence ACL is torn. In varus violence the lateral structures are disrupted first followed by the cruciates. In hyperextension injuries ACL is torn first and with continued violence posterior capsule and posterior cruciate ligament is torn. History of locking episodes, click and clunk are suggestive of associated meniscal injury. History of patient socioeconomic status, occupational and personal requirements of the patient are important in individualizing patient treatment.

PHYSICAL EXAMINATION

General examination of the patient with inspection, palpation, measurements and movements of the knee joint are done which is followed by various test to accomplish the diagnosis and plan the treatment. The tests for cruciate ligaments, collateral ligaments and meniscus are done.

- Lachmans test
- Anterior drawer test
- Slocum test
- Pivot shift test
- Mcmurrays test for meniscus
- Valgus varus stress test for collateral ligaments

Lachman Test[30]

This test is done with patient supine and relaxed. The side affected is placed towards the examiner or examiner stands by the affected side. Patient is asked to relax and the limb is externally rotated to relax the limb. Distal part of the thigh is grasped with one hand and proximal leg is grasped with the other so that the thumb of the hand holding the leg is in the medial join line. Holding the limb in this position a firm pressure is

applied in an attempt to move the proximal tibia anteriorly and posteriorly. The anterior translation of the tibia can be palpated with the thumb of the hand holding the leg. Any anterior translation of the tibia with a mushy end point signifies ACL tear.

When patients presents with heamarthrosis knee cannot be flexed to 90 degrees and anterior drawer test is difficult to do. In those situations Lachmans test is useful. Also Lachmans test is more sensitive than anterior drawer test in testing anterior cruciate ligament integrity.

Figure 4: Lachmans test

ANTERIOR DRAWER TEST *(31)*

This test is done with patient supine. The hip is flexed to 45 degrees and knee joint flexed to 90 degrees, foot is stabilized by examiner sitting on the dorsum of the foot, hamstrings made to relax by placing the

fingers of both the hands behind the knee and the proximal tibia is gently pulled forward. Any movement of tibia over femur is noted and compared with the opposite knee.

Pull of 6-8 mm more than the opposite knee with a mushy end point indicates anterior cruciate ligament tear.

False positivity can occur in inherited ligament laxity, posterior cruciate ligament tear. False negativity can occur in obese patients, hamstring spasm, heamarthrosis and mechanical block.

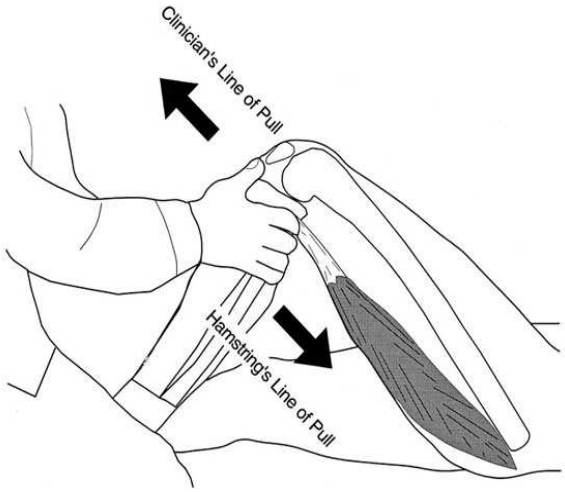


Figure 5: Anterior drawer test

SLOCUM TEST

Slocums modification of the anterior drawer test is performing the anterior drawer test in neutral, 30 degree external rotation and 15 degree internal rotation. Accentuated anterior translation in external rotation

indicates anteromedial instability and increased translation in internal rotation indicates anterolateral instability.

PIVOT SHIFT TEST[32]

The foot is lifted with the knee extended and internally rotated. Valgus stress applied to the lateral side of the leg in the region of the fibular neck with the opposite hand and when the knee is slowly flexed while valgus and internal rotation being maintained the anteriorly subluxated knee relocates at around 30 degrees of flexion. This test is difficult to do with muscle spasm and it can be demonstrated easily with the patient anaesthetised.

Figure 6: Pivot shift test

RADIOGRAPHIC EVALUATION

X-rays of the knee joints are necessary to rule out any fractures, degenerative changes, and malalignment. Plain films can demonstrate

haziness in Hoffa's fat, a joint effusion, and may reveal subtle fractures of the posterior tibial plateau, impaction of the lateral sulcus, or an avulsion of the lateral tibial rim called as Segonds fracture. Tibial attachment avulsions are more commonly detected on plain radiograph and are seen more commonly in younger patients. Stress views are taken to demonstrate the ACL injury radiographically. Anterior drawer sign is elicited and lateral views are taken with and without stress. An anterior translation of more than 5 mm is significant to call it abnormal. A difference of more than 3 mm with the contralateral knee is significant.

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging offers direct, noninvasive visualization of the ACL and other soft tissue structures, improving the preoperative assessment of internal derangement. The accuracy of MR imaging for evaluation of ACL pathology is high. Using direct signs, sensitivities are as high as 92% to 94% and specificities are as high as 95% to 100%[33].

The patient is placed supine with the knee within the extremity coil, avoiding excessive extension or flexion. Sagittal images are the most useful for evaluation of ACL fiber orientation and the femoral and tibial attachments. If the ligament is not adequately visualized on routine

sagittal views, then additional sequences may be supplemented with thin cuts through the intercondylar notch and oblique images plotted parallel to ACL on coronal or axial views. Images in the coronal plane are useful for evaluation of the collateral ligaments and for assessing the signal characteristics of the ACL within the intercondylar notch in equivocal cases. On coronal views, the ACL appears coursing posterior superolateral to anterior inferomedial.

Axial views are useful for assessment of the ACL and posterior cruciate ligament (PCL) in the notch, bone contusions, para-articular fluid collections, and the joint capsule. T1-weighted images, although useful for delineation of bony anatomy, are not adequate for evaluation of edema. Inversion recovery and / or T2-weighted images with fat suppression are sensitive for visualization of marrow edema and fractures. Either fast spin-echo or conventional spin-echo imaging can be used to assess the ACL. On sagittal views, the normal ACL (with knee in extension) should have a taut, straight anterior margin, with low signal intensity of its fibers on all pulse sequences and fiber striation visible at its attachments.Propeller or fanlike configuration.

Figure 7: MRI showing normal ACL in sagittal plane

Figure 8: MRI showing normal ACL in coronal plane.

In this plane, the normal ACL often appears much more attenuated than in the sagittal plane

INJURED ACL IN MRI

Direct MR imaging signs of acute ACL tear include poor or non-visualization of the ACL on sagittal images, an amorphous edematous mass with focally increased signal on T2-weighted images, irregular contour with wavy redundant fibers, or interruption of fibers with tears seen midsubstance or at the tibial or femoral attachments.

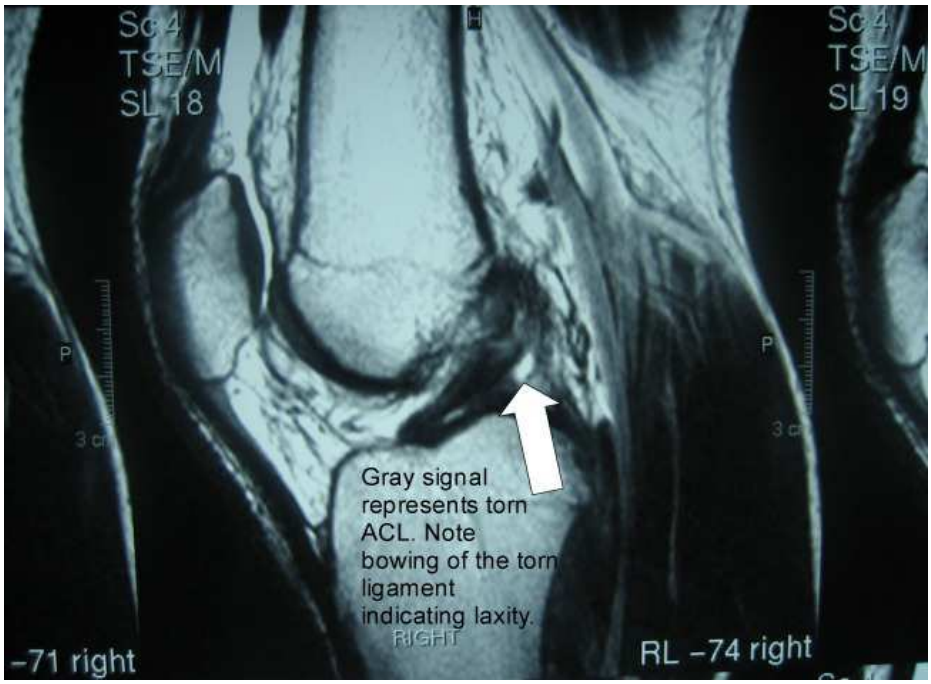


Figure 9: MRI showing injured ACL

TYPES OF ACL RUPTURE

Partial

Complete

Avulsion

SITE OF RUPTURE

- Inferior attachment site which is usually avulsion fracture of the tibial spine
- At or about the superior attachment site
    - Within the body of the ligament. This is the most common site of tear. The anteromedial and posterolateral bundles can be torn separately without involving the other.

MANAGEMENT

The aim of ACL reconstruction treatment is to attain functional stability of the knee. An isolated rupture of the ACL is an extremely common injury and most commonly results in instability of the knee. For an active, healthy person who wishes to reach some state where he/she can perform athletic activities, reconstruction of the ACL is recommended. A minimum ROM of 5-90° is usually desired and should be achieved before surgical intervention.

There are three types of procedures for ACL insufficiency.

1. Extra articular reconstruction
2. Intra articular reconstruction
3. Combined

EXTRA ARTICULAR TECHNIQUES

1. Iliotibial band tenodesis
2. Biceps plasty

INTRA ARTICULAR TECHNIQUES

1. Transtibial technique
2. Transportal technique
3. Single bundle reconstruction
4. Double bundle reconstruction

GRAFT SELECTION[34]

The success of ACL reconstruction does not depend on type of graft but on the technique used for the surgery such as placement of graft and rehabilitation methods. The various types of grafts are :

1) Patellar tendon graft

Advantages:

- High initial tensile strength
- Good bone to bone healing
- Acceptable harvest morbidity

Disadvantages:

- Patellofemoral pain
- Tendinitis
- Patella fracture
- Quadriceps weakness

2) Hamstring tendon graft

Advantages:

- Less donor site complications

Disadvantages:

- Good tensile strength only when folded double or triple
- late soft tissue to bone healing

3) Allograft

Advantages:

- Improved cosmesis
- Less operative time
- Eliminate donor site morbidity
- Unlimited graft supply

Disadvantages:

- High cost
- High disease transmission
- Later graft incorporation
- Alteration of graft pain

4) Synthetic grafts

Advantages:

- Good postoperative results

Disadvantages:

- Eventual mechanical failure

MATERIALS

AND

METHODS

MATERIALS AND METHODS

The Retrospective and prospective study of 60 patients treated with arthroscopic anterior cruciate ligament reconstruction with quadrupled hamstring graft with endobutton as the femoral fixation device and titanium interference screw (no=30) and bioabsorbable interference screw (no=30) as tibial fixation device respectively between May 2012 and November 2013 at institute of orthopaedics and traumatology, Rajiv Gandhi government general hospital, Chennai

INCLUSION CRITERIA

- Patients with closed growth plate
- Primary ACL surgery
- No evidence of multiple ligament injury
- No previous knee surgeries
- No ligamentous injury to contralateral knee

EXCLUSION CRITERIA

- Additional ligamentous laxity in affected knee
- Previous ACL surgery of either knee
- Chronic muscle disorders

- Any co-existing local conditions in the form of
    - -Active articular infection
    - -Inflammatory joint disease
- Metabolic bone disease
- Neoplastic disease

INSTRUMENTATION

Many specialized instruments are required for arthroscopic anterior cruciate ligament reconstruction. An arthroscopic system which consist of

1. Television monitor
2. Camera
3. Light source and fibre optic light source cable
4. Arthroscope (30 degree)
5. Shaver system and hand piece
6. Tourniquet set (Pneumatic)

Equipments needed for surgery are

- 2.4mm drill tip guide pins
- Trocar, canula, ACL probe
- Meniscus punch
- 3.5 and 4.5 shaver blades
- Tibial aiming guide

- Cannulated headed reamers (size 5mm to 10mm)
- Transtibial femoral ACL drill guide (usually 7 – mm offset tip)
- Extra long 2.4 mm guide pin with suture eye (Beath – type guide pin)
- 4.5 mm cannulated reamer for passage of endobutton
- Depth gauge
- Sizing block
- Cannulated interference screws
- Endobutton
- 1.5 mm guide wire with screw driver for passage of bioabsorbable interference screw

IMPLANTS

The fixation options for soft tissue grafts in femur can be direct devices like interference screws and washers. The indirect devices like endobutton, femoral cross pins, suture discs and anchors are also available. Fixation options in tibia are interfernce screws, staples, screw and washer(Washerloc).We used endobutton for femoral fixation and titanium interference screws for 30 patients and bioabsorbable interference screws for 30 patients in the tibia respectively.

ENDOBUTTON

Endobutton is preferred by most of the surgeons nowadays. It ensures most of the graft in the tunnel. Endobutton has 4 holes of which central two holes are used to create the loop for quadrupling the graft.The peripheral two holes are for passing wires which are used to flip the endobutton. Endo button was stronger than RCI screw and bio screw in withstanding cyclical loads and has a greater advantage of not lacerating the soft tissue graft.

Figure 10: Endobutton

INTERFERENCE SCREW

Interference screws are direct fixation device which hold the graft to bone having inserted between the graft and the bone tunnel. These are made of variety of materials. Round contoured interference screws, bio absorbable interference screws, titanium interference screws are available. We used regular titanium interference screws for 30 patients and bioabsorbable interference screws for 30 patients. These interference screws which provide juxta articular fixation increase the stability of the

knee joint than the implants which suspend the graft or fix the graft at the surface of the joint. However studies have proved that interference screws to be inferior to the endobutton and the bone mulch screw. One another concern was the laceration that interference screw can cause to the soft tissue graft. But in spite of the concerns interference screw fixation of soft tissue grafts have shown comparable results with that of interference screw fixation of bone patellar tendon bone grafts.

Figure 11: Titanium Interference screw Figure 12: Bioabsorbable Interference screw

Bioabsorbable screw is made of poly-L-lactide and degradable over two to six years. The advantages of the screw are

- Straightfoward technique
- graft will not be damaged (as seen in mettallic)
- Cannualation in the screw allow precise placement in the tunnel.

METHODS

PREOPERATIVE WORK UP

Patients with ACL tear proven clinically and radiologically are admitted in Institute of Orthopaedics and Traumatology. Routine investigations like heamoglobin, total and differential counts, platelet count, ESR, blood sugar, renal parameters, chest X-ray, ECG were taken and anesthetist assessment for regional and general anesthesia was done. Static and dynamic quadriceps exercise was taught to patients while awaiting surgery.

ANAESTHESIA AND PATIENT POSITIONING

All patients are operated under spinal anesthesia. In supine position under anesthesia anterior drawer test, posterior drawer test, Lachmans test, pivot shift test are done. With patient supine knees are flexed to 90 degrees and a removable side support is placed in the side of the table to support the ipsilateral thigh, a foot stopper is placed beneath the foot after flexing the knee to 90 degrees. In all the cases a pneumatic tourniquet is used which is placed in the upper thigh after soft padding. The limb is shaved around the knee joint and prepared with betadine pre scrub. Limb is draped exposing the knee joint lower thigh and upper leg after painting the limb with betadine. A preoperative antibiotic usually 1 g cefotaxime

is given before inflating the tourniquet and limb is held upright for 3 minutes to exanginuate the limb before inflating the tourniquet.

Figure 13: Patient positioning

ARTHROSCOPIC PROCEDURE

An anterolateral portal is established 1 cm lateral to the patellar tendon midway between the inferior pole of the patella and the upper end of the tibia. Trocar and canula inserted with knee extended in to the suprapatellar pouch. Inflow of normal saline from 3 liter saline bottles is maintained through the TURP set. After adequate inflation of the joint space scope is introduced and a diagnostic arthroscopy is done visualising suprapatellar pouch, lateral gutter, intercondylar notch, articular surface of patella, medial gutter and articular surfaces of femur and tibia. An anteromedial portal or the working portal is established 1 cm medial to the patellar tendon midway between the inferior pole of patella and the upper end of the tibia. The meniscus are visualised and probed to reveal meniscal tears. Anterior cruciate ligament is probed to analyse the

amount of tear. If unstable meniscal injuries are found they are treated with partial menisectomy and debridement depending on the site and type of the tear.

GRAFT HARVEST AND PREPARATION

A 2 to 3 cm oblique incision is placed over the anteromedial aspect of tibia exactly over the pes anserinus which is identified by palpating the semitendinosus and gracilis tendon by running the fingers from above downwards in the anteromedial aspect of the upper tibia. The tendons slip under the finger during this gentle palpation. Skin subcutaneous tissue is incised along the incision and blunt dissection is done to expose the sartorius fascia which is lifted up with a forceps and cut with a number 11 scalpel.

After incising the sartorius fascia the gracilis and semitendinosus tendons are indetified and localised using a right angle forceps. The tendons are freed from all soft tissue attachments in the anteromedial tibia and around their insertions. Then the tendons are secured with 1 vicryl near their insertions and the tendons are detached from their insertions one by one as long as possible. Holding the vicryl tied to the tendon a closed tendon stripper is inserted encircling the tendon and the tendon stripper is advanced with a minimal countertration. The stripper is carefully advanced towards the ipsilateral ischial tuberosity with knee in

70 degree flexion and undue care is taken to prevent the amputation of the graft. The stripper is advanced until the tendon muscle junction is cut and the tendon comes out through the incision.

Figure 14: Quadrupled Hamstring Graft

The tendons are cleared of the muscle attachments and free ends of the tendons are stitched together with a running whip stitch 4 to 5 cm from the free ends with polybraided nonabsorbable number 2 suture material (Ethibond). Mannual tensioning of the tendon is done and the tendons are passed through the loop made in the endobutton with number 5 non-absorbable suture material (ethibond) or through the loop of the endobutton CL ultra so that the tendons are quadrupled for reconstruction. The free ends of the combined gracilis semitendinosus tendons are again whip stitched with a number 2 nonabsorbable suture material.Then the graft size is mesured with a sizer by pulling the graft through the sizer and the graft is kept aside rolled in a moist cotton gauze pad.

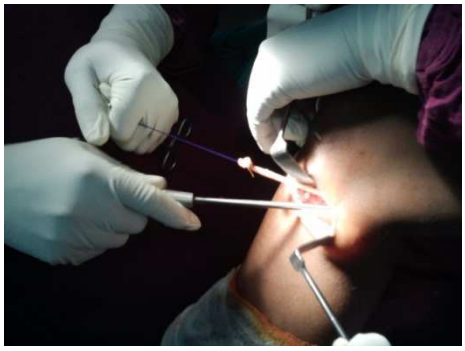


Figure 15: Graft harvest

INTRAARTICULAR PREPARATION

The arthroscope is introduced through the anterolateral portal and the 4.5 or 3.5 shaver blade is inserted through the anteromedial portal and the joint is debrided of the ligamentum plicae, some pad of fat and some synovial reflections which hinder a through visualization of the medial surface of lateral femoral condyle, the over the top position and the tibial foot print of the anterior cruciate ligament.The medial surface of the lateral femoral condyle is shaved of the native ACL remanents and the over the top position is identified without misinterpreting the students ridge. Then the ACL foot print in the tibia is prepared. Throughout this joint debridement undue care is taken to avoid injury to the native posterior cruciate ligament.

TIBIAL TUNNEL

The tibial guide or the guide pin targeting tibial jig is used to create the tibial tunnel. The guide is set at 55 degree or by N+7 rule where N is the effective length of the tendon. With the guide set in 55 degrees the tip of the guide pin is positioned in the ACL foot print in the posterior half. The guide can also be placed using various land marks like posterior rim of the anterior horn of the lateral meniscus, anterolateral part of the medial tibial intercondylar eminence, 8 mm anterior to the posterior cruciate ligament.

After establishing the proper position of the guide tip the guide pin sleeve is inserted and advanced to the anteromedial part of the tibia. The guide pin sleeve is flushed with the anteromedial cortex of the upper tibia midway between the tibial tuberosity and the posterior border of the proximal tibia. The guide pin sleeve is inserted and advanced through the incision made for harvesting the graft by retracting the skin edges. Before drilling the tibial tunnel the arm of the tibial guide is ensured to be parallel with the tibial plateau. Then the 2.4mm drill tip guide wire is drilled through the tibial cortex to exit intraarticularly which is visualized with the arthroscope. When the 2.4 mm drill tip guide wire had been exactly placed intra articularly the tibial guide and the guide sleeve is

removed. Serial reaming of the tibial tunnel over the guide pin is done with cannulated calibrated reamers up to the desired size of the graft. During all these drilling a small curved curette is placed intraarticularly to prevent the tip of the guide pin or the reamers from damaging the articular surface of the joint. Once the tibial tunnel has been created the posterior end or the intraarticular exit of the tibial tunnel is shaved of the soft tissues and bone particles from obstructing the graft passage. Even a sharp dissection can be used for this purpose and a rasp is used to smoothen the tunnel walls for easy graft passage and to avoid graft damage.

FEMORAL TUNNEL

The femoral tunnel is created by trans tibial technique in most of the patients and transportal technique in rest of the patients in our study. In transtibial technique, femoral tunnel is drilled through the tibial tunnel and in transportal technique, femoral tunnel is drilled through a separate medial portal with the help of femoral offset. The femoral aimer is placed in the intercondylar notch at 1'O clock position for the left knee and 11'O clock position for the right knee. The 7 mm offset aimer is placed so that it is placed over the posterior edge of the notch to avoid blow out and to leave atleast 2mm of intact posterior cortex. If the graft diameter is greater than 10mm then the offset guide may need to be placed little more

anteriorly to avoid posterior blow out. Having placed the aimer the long drill tip guide wire is drilled through the lateral femoral condyle to exit in the anterolateral aspect of the lower thigh.

The intrarticular length of the graft is measured and the lateral femoral condyle is drilled with 4.5 mm reamer until the anterolateral cortex is breached to create a passing tunnel for the endobutton.

After reaming the lateral condyle the length of the femoral condyle is measured with a depth gauge. Having known the intra articular length of the graft and the whole length of the graft, the length of the graft to be in the femoral condyle can be desired and marked, which is usually the half the length of the remaining graft after subtracting the intraarticular length from the total length. Having known the length of the femoral condyle and the desired graft length in the femur, the loop length to be adjusted in the endobutton is calculated and the loop is created or a adequate length looped endobutton CL ultra is chosen. The femoral condyle is reamed with a appropriate size reamer as of the graft to a length of around 5 to 6 mm greater than the desired graft length for the turning radius of the endobutton. The tunnel is smoothened with a rasp or the shaver blade and the soft tissue interposition for the graft passage is removed adequately.

GRAFT PASSAGE AND FIXATION

In the peripheral holes of the endobutton two 5 number suture material is passed and taken through the eyelet of the guide pin so that it can used as a leading suture and as a toggle suture. The guide pin is passed through the tunnel and pulled through the tunnel and extracted along with the suture material in the anterolateral aspect of the distal thigh. The leading suture is pulled so that the graft is pulled through the tunnel headed by the end of the endobutton to which the leading suture is passed. The graft is pulled until the desired length of the graft is pulled in to the femoral condyle and the trailing suture is pulled to flip the endobutton. Once the endobutton is flipped and confirmed by arthroscope in the anterolateral aspect of the femur, the distal part of the graft is pulled down to seat the endobutton so that the femoral fixation is done. With manual tension to the distal graft the knee is taken through range of motion to cyclically tension the graft and to look for impingement. If there is impingement of the graft the notch is slightly enlarged to avoid impingement. After tensioning the graft the tibial site is fixed with appropriate size titanium interference screw or bioabsorbable interferencescrew depending on the study group and ensured endoscopically that the screw has not breached the articular surface.

Figure 16: Femoral tunnel fixed by endobutton

CLOSURE

The wound is closed in layers after through wash. The portals are closed with single sutures with nonabsorbable suture material after placing a intraarticular suction drain. Sterile dressing applied over the wound and knee brace applied in extension after tourniquet is released.

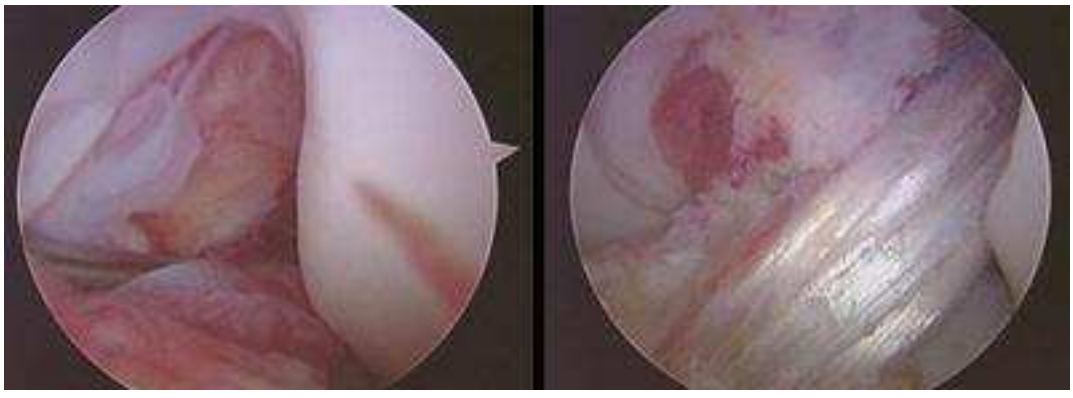


Figure 17: Torn ACL & Reconstructed ACL with Hamstring graft

POST OPERATIVE MANAGEMENT

- Immobilisation in knee brace and limb elevation immediate post operatively
- Intravenous antibiotics for 3 days
- Drain removal on 2nd Post operative day
- Wound inspection on 2, 5, 7 Post operative day.
- Suture removal on 12th Postoperative day
- Gradual physical rehabilitation
- Follow up at 4, 8 weeks and 3, 6 months

POST OPERATIVE REHABILITATION

The general post operative protocol for anterior cruciate ligament reconstruction is followed and progression of the rehabilitation is individualized for each patient. Emphasis on arthrofibrosis, joint contracture and joint laxity has been made.

***Goals*:** Full range of motion (ROM), normal gait pattern, stability of the knee joint, pain free movement.

1st Postoperative day

- Rest in extension in long knee brace
- Static quadriceps exercise
- Ankle and foot movement and limb elevation.

0 – 2 Weeks

- Full knee extension ROM
- 90 degrees knee flexion ROM
- Strong QS/SLR without extention lag
- Emphasize normal gait pattern
- Passive, active, and active – assisted ROM knee flexion
- Partial weight – bearing 50% to 75% with walker or weight-bearing to tolerance with knee immobilizer with a walker

2 – 4 weeks

- Full extension to 120 degrees flexion
- Full weight bearing without
- Progress SLR with weights
- Walking, emphasis on normal gait.

4 – 10 Weeks

- Progress to full ROM by 6 weeks
- Progress closed chain exercises
- Progress all the exercises

12-14 Weeks

- Initiate full range knee extension exercises, light weight and high repetition.
- Initiate jogging program

16 –18 weeks

- Isokinetic strength test for quadriceps and hamstrings
- Agility training and sport-specific training

EVALUATION

All the patients are subjected for post-operative anteroposterior and lateral radiographs to determine the tunnel placement and position of endobutton in femur and interference screw in the tibia. Patients are followed at 4 weeks, 8 weeks, 3months, 6 months and once in 6 months thereafter.

All patients are evaluated with Lysholm & Gillquist scoring.

KNEE SCORING SCALE OF LYSHOLM & GILLQUIST

Limp

None	05
Slight /periodic or both	03
Constant or severe or both	00

Support

None	05
Cane or crutch	02
Weight bearing impossible	00

Locking

No locking or catching sensations	15
Catching, but no locking sensations	10
Locking - occasionally	06

Locking - Frequently	02
Locked on examination	00

Instability / Giving Way

Never	25
Rarely during athletic activity or any other heavy exertion	20
Frequently during athletics or any other heavy exertion	15
Rarely in daily activities	10
Frequently in daily activities	05
At every step	00

Pain

None	25
Inconstant or slight during heavy exertion	20
Marked during heavy exertion	15
Slight during a walk >2 km	10
Marked during a walk <2 km	05
Constant	00

Swelling

None	10
Mild on exertion	06
Marked on exertion	02
Constant	00

Stair Climbing

No problems	10
Slightly impaired	06
One step at a time	02
Impossible	00

Squatting

No problems	05
Slightly impaired	04
Knee flexion possible only up to 90 degrees	02
Impossible	00

STATISTICAL ANALYSIS :

Data reported as mean and significant difference between the two groups was studied using Yate's corrected Chi-Square test.

OBSERVATIONS

&

RESULTS

OBSERVATION AND RESULTS

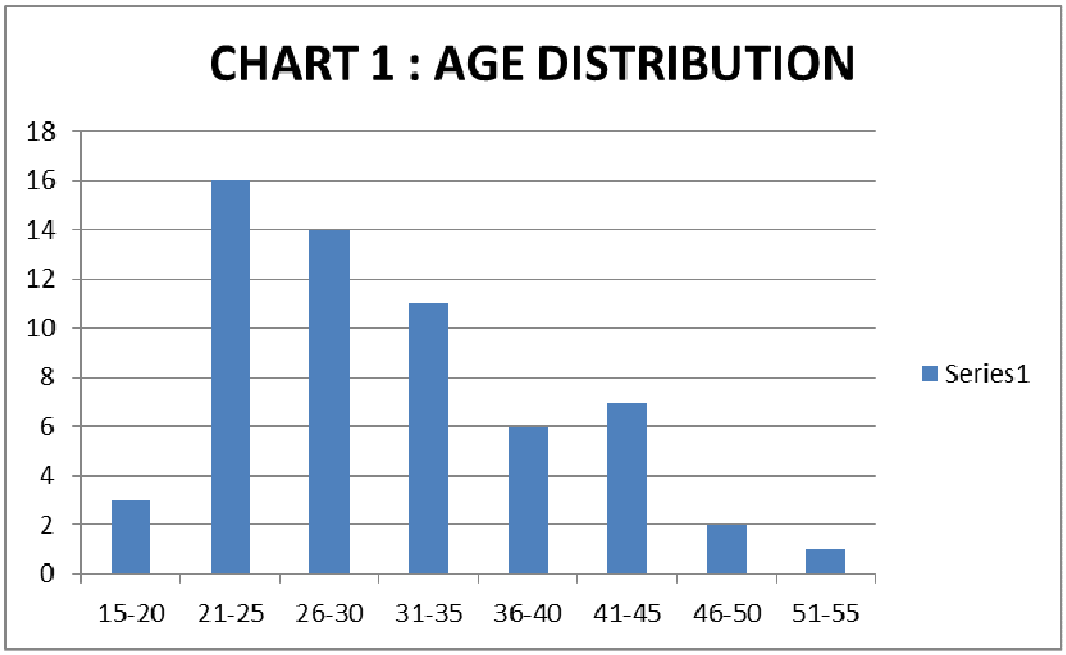
60 Cases of arthroscopy assisted Anterior cruciate ligament reconstruction with quadrupled hamstring tendon graft using endobutton as the femoral fixation device and titanium interference screw (no=30) and bioabsorbable interference screw (no=30) as tibial fixation device respectively was followed for 6 months to 1.5 years. The mean follow up was 10.5 months

AGE DISTRIBUTION

Minimum age was 20 years and maximum age was 55 with a mean age of 31.6 (Table 1 and Chart 1)

Table 1: Age distribution

AGE	PATIENTS	PERCENTAGE
15-20	3	5
21-25	16	26.66
26-30	14	23.33
31-35	11	18.33
36-40	6	10
41-45	7	11.66
46-50	2	3.33
51-55	1	1.66
TOTAL	**60**	**100**

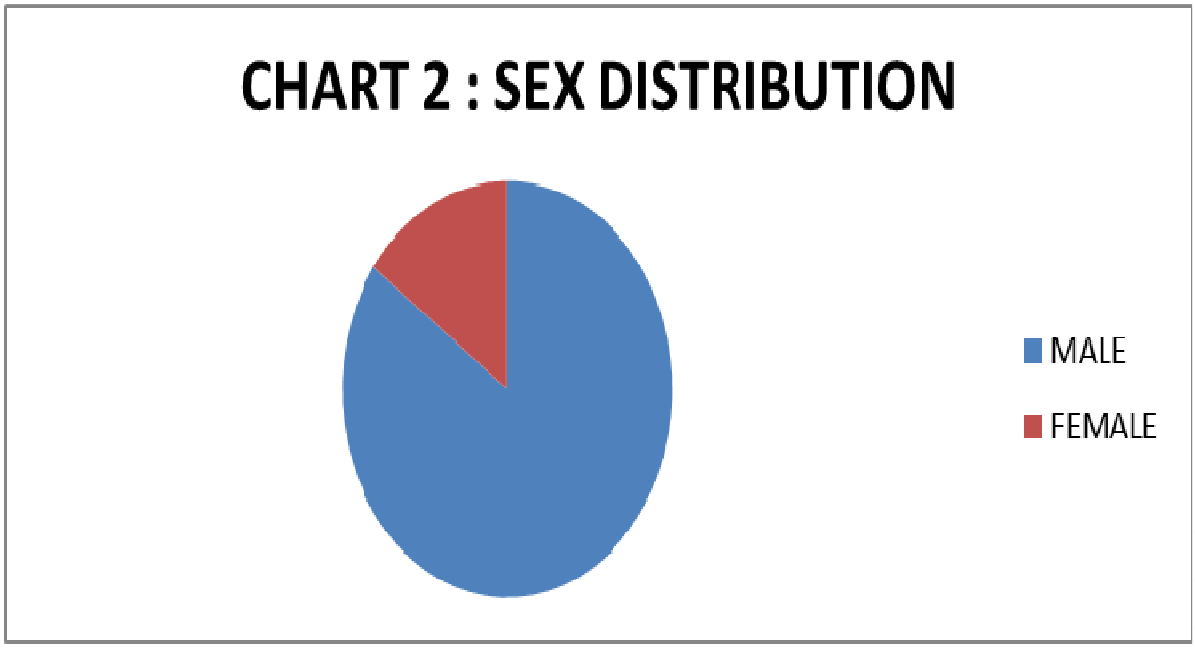


SEX DISTRIBUTION

In this study, 51 patients were males and 9 patients were females (table 2 and chart 2)

Table 2: Sex distribution

SEX	PATIENTS	PERCENTAGE
MALE	51	85
FEMALE	9	15
TOTAL	60	100

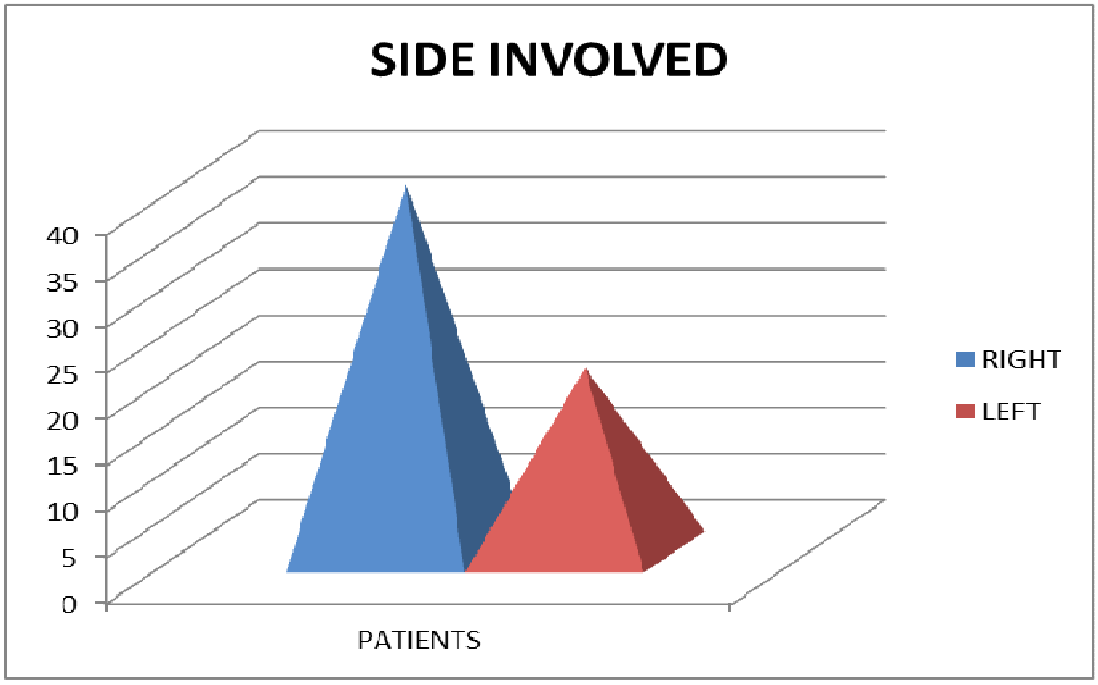


SIDE INVOLVED

In this study, 40 patients had injury in the right knee and 20 patients had injury in the left knee (Table 3 and Chart 3)

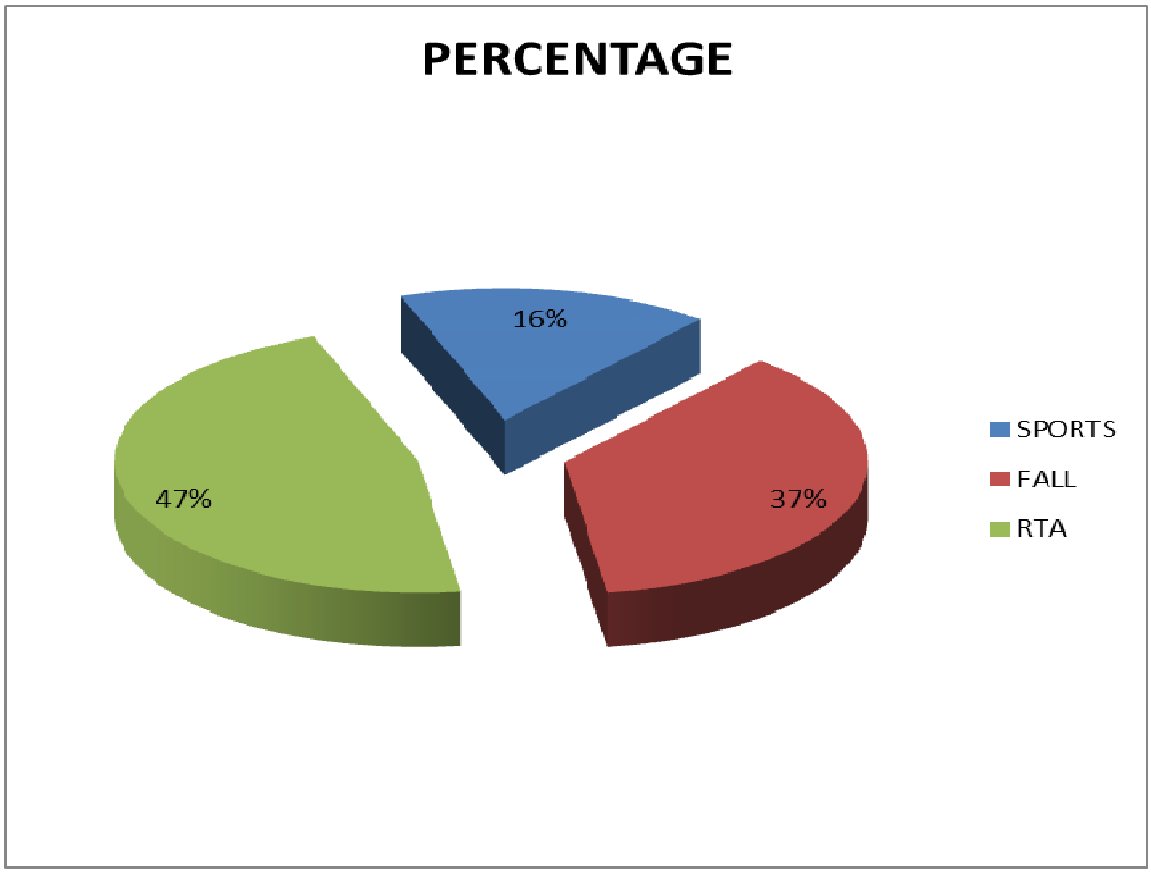
Table 3: Side involved

SIDE INVOLVED	PATIENTS	PERCENTAGE
RIGHT	40	66.66
LEFT	20	33.33
TOTAL	60	100



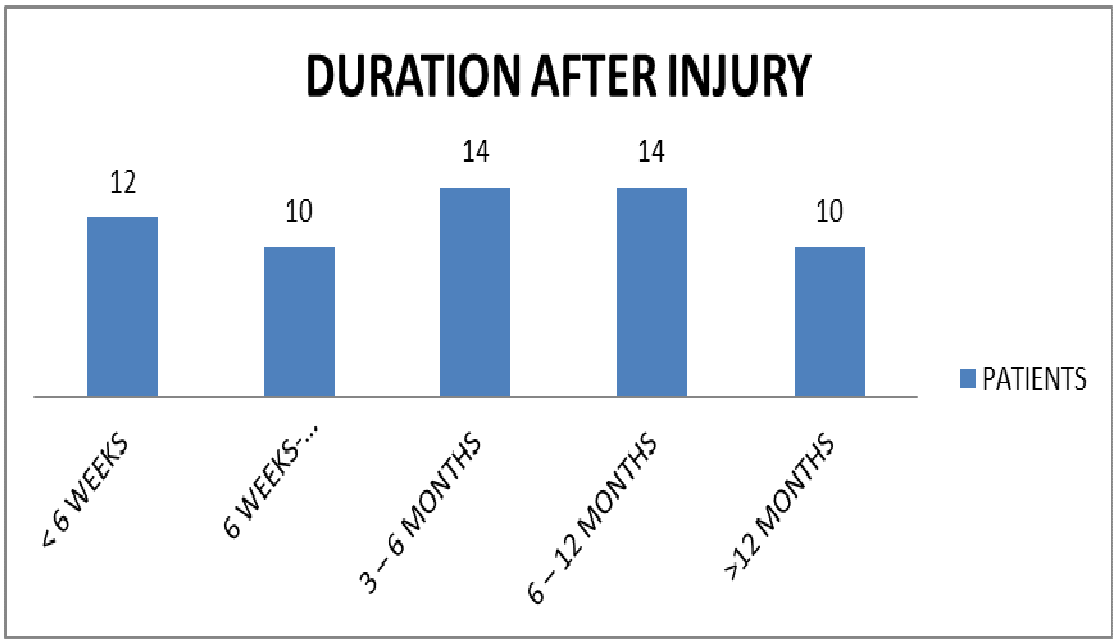
MODE OF INJURY

MODE OF INJURY	PATIENTS	PERCENTAGE
SPORTS	10	16.6
FALL	22	36.66
RTA	28	46.66
TOTAL	60	100



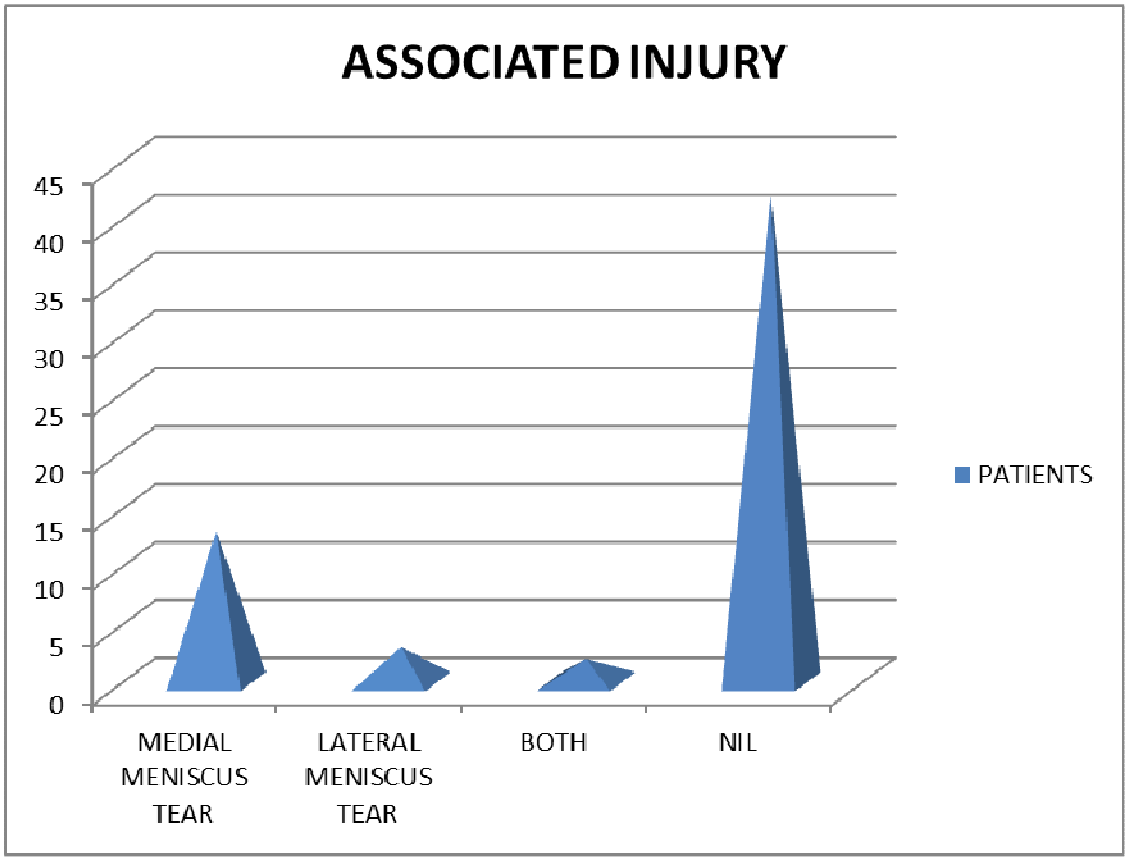
DURATION OF INJURY

DURATION AFTER INJURY	PATIENTS	PERCENTAGE
<6 WEEKS	12	20
6-3 MONTHS	10	17
3-6 MONTHS	14	23
6-12 MONTHS	14	23
>12 MONTHS	10	17
TOTAL	60	100



ASSOCIATED INJURY

ASSOCIATED INJURY	PATIENTS	PERCENTAGE
MEDIAL MENISCUS TEAR	13	22
LATERAL MENISCUS TEAR	3	5
BOTH	2	3
NIL	42	70
TOTAL	60	100



OBSERVATION

- Greater number of our patients was seen in the younger age group of 20-40 years.
- Male preponderance was noticed in our study
- Right side was involved more commonly than left side
- Road traffic accident was the most common cause accounting for ACL injury.
- Medial meniscus injury was involved more than the lateral meniscus.
- Most of the patients returned to their pre-functional level at 4 months.

SCORING ANALYSIS

60 patients of arthroscopic acl reconstruction with quadrupled hamstring graft was followed for a minimum period of 6 months and maximum period of 1.5 years.All patients are evaluated with Lysholm and Gillquist scoring at the end of 6 months. The maximum score achieved was 100 and minimum score was 56.The scores were graded as

Outcome	Points
Good	84 - 100
Fair	65 - 84
Poor	< 65

Two patients in titanium interference group and one patient in bioabsorbable interference screw group lost to followup.

Outcome	Titanium screw gp.no of patients(28)	Percentage	Bio-abs screw gp. No of patients (29)	Percentage
Good	23	82.14	24	82.75
Fair	3	10.71	3	10.34
Poor	2	7.14	2	6.89

By Yates corrected Chi-Square Test,

$X^2 = 0.06$ $P = 0.97$

The clinical outcome was nearly equal in both the groups.

GOOD RESULTS

In our study 23 patients in titanium interference screw group and 24 patients in bioabsorbable interference group had good results and the patients had no limp, were able to walk without support, there was no locking except for a few with mild instability during athletics or heavy exertion. There was no pain or swelling of the knee joints. There was no difficulty in climbing stairs or squatting.

FAIR RESULTS

In both the groups, 3 patients had fair results with the following clinical findings. There was slight limping, occasional locking, with mild instability during daily activities. There was anterior pain and swelling on exertion. squatting and stair climbing were slightly impaired.

POOR RESULTS

In both the groups, 2 patients had poor results, with painful weight bearing. The patient walked with support, and felt the knee giving way in daily activities. There was constant swelling and pain of anterior knee joint. Squatting and climbing stairs was painful.

The above 4 patients with poor results had lachmans and anterior drawer test positive with restricted knee movements. These may be due to improper graft tension and in cooperation during postoperative

rehabilitation.2 of the 4 patients had infection and septic arthritis 10 days following which subsided with arthrotomy and joint lavage and antibiotics.

COMPLICATIONS

One patient had post-operative infection and patient presented on 10^{th} post-operative day with fever, pain and inability to move the limb. Septic arthritis was suspected and patient treated with open arthrotomy and joint debridement and antibiotics for 4 weeks and infection subsided.

The most common intraoperative complication proposed for bioabsorbable interference screw were screw breakage , graft injury and aseptic effusion or synovitis of knee joint, but we did not encounter such problems in our study.

ILLUSTRATIVE CASES

CASE ILLUSTRATIONS

CASE SERIAL NO-1

Name: Mr. Kumar Age: 32 Sex : Male

Occupation	:	Electrician
Duration between Injury & Surgery	:	14 months
Date of Admission	:	08-10-2012
Mode of Trauma	:	Fall
Side Involved	:	Right Side
Associated Injuries	:	Nil
Systemic Illness	:	Nil
Type of Anaesthesia	:	Spinal
Complication	:	Nil
Lysholm Gillquist score	:	100
Post op follow up	:	08 months
Screw used	:	Titanium interference screw


Kumar 31/M
1402
*8/10/1982, M, 31Y
STUDY 1
8/10/2013
12:12:00 PM
7 IMA 10 / 18
HLA
Aarthi Scans Tambaram
MAGNETOM_ESSENZA
MR C15
FFS
+LPH
AR
MF 1.22
TR 3200.0
TE 62.0
TA 02:08
BW 150.0
M/NORM/DIS2D
A1
C:FL
*tse2d1_11 / 150
RT KNEE JOINT
D/E
TP F10
SP R82.5
SL 2.0
FoV 160*160
224*320s
Sag>Cor(26.5)>Tra(0.9)
W 1156
C 592

CASE SERIAL NO-2

Name: Mrs. Gunavathy Age: 45 Sex: Female

Occupation	:	House wife
Duration between Injury & Surgery	:	8 months
Date of Admission	:	07.01.13
Mode of Trauma	:	RTA
Side Involved	:	Left Side
Associated Injuries	:	Lateral meniscus tear
Systemic Illness	:	Nil
Type of Anaesthesia	:	Spinal
Complication	:	Nil
Lysholm gillquist score	:	95
Post op follow up	:	11 months
Screw used	:	Titanium interference screw


GUNAVATHY 45/F
1763
*10-Jul-1967, F, 45Y
STUDY 1
10-Jul-2012
11:23:17
13 IMA 10 / 1
HLA BARNARD INSTITUTE OF RADIO
AR
MF 1.16
TR 450.0
TE 12.0
TA 03:49
BW 130.0
M/ND/FM
A2
EX
*se2d1 / 90
LT KNEE
GUNAVATHY 45/F
1763

CASE SERIAL NO-3

Name: Mr.Srinivasan Age: 38 Sex: Male

Occupation	:	Manual worker
Duration between Injury & Surgery	:	14 months
Date of Admission	:	03-06-2013
Mode of Trauma	:	Fall
Side Involved	:	Right Side
Associated Injuries	:	Nil
Systemic Illness	:	Nil
Type of Anaesthesia	:	Spinal
Complication	:	Nil
Lysholm Gillquist score	:	92
Post op follow up	:	6 months
Screw used	:	Bioabsorbable interference screw


SRINIVASAN 35/M
HL BARNARD INSTITUTE OF RADI
1197
*25-May-1978, M, 35Y
STUDY 2
25-May-2013
13:19:21
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A
5cm
TR 5550.0
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SRINIVASAN 35/M


R

CASE SERIAL NO-4

Name: Mrs. Indhumathi Age: 35 Sex: female

Occupation	:	House wife
Duration between Injury & Surgery	:	6 months
Date of Admission	:	10-06-2013
Mode of Trauma	:	Fall
Side Involved	:	Right side
Associated Injuries	:	Nil
Systemic Illness	:	Nil
Type of Anaesthesia	:	Spinal
Complication	:	Nil
Lysholm Gillquist score	:	95
Post op follow up	:	6 months
Screw used	:	Bioabsorbable interference screw


RT KNEE JOINT
Kumar 31/M
HLA
STUDY 1
8/10/2013
12:11:59 PM
AR
MF 1.22
TR 3200.0
TE 82.0
TA 02:08
BW 150.0
MNORM/DIS2D
A1
C:FL
RT KNEE JOINT

DISCUSSION

DISCUSSION

Incidence of anterior cruciate ligament reconstruction had increased significantly in the past decade [35] owing to the increased number of road traffic accidents and more involvement in sports activities. Indications for surgical treatment are repeated symptoms of knee instability. Arthroscopic ACL reconstruction have become gold standard and open reconstruction have become almost obsolete nowadays.

Eventhough arthroscopic reconstruction have been standardised the controversies regarding graft choice, graft fixation methods and technique of reconstruction like single bundle or double bundle and trans tibial or trans portal are still in debate. In the past decade ACL has been widely studied and various scientific articles have been published on ACL reconstruction techniques and outcomes. The goal of reconstruction is to provide a normal stable joint with full function and to prevent the complications following ACL tear like meniscal injury and secondary osteoarthritis.

Our study is to evaluate the functional outcome of arthroscopic single bundle ACL reconstruction with quadrupled Hamstring graft with transtibial and transportal techniques using endobutton as femoral fixation device and titanium interference screw in 30 patients and bioabsorbable interference screw in 30 patients as tibial fixation device.

In our study fall and road traffic accidents predominated as the cause of injury accounting for 37% and 47% respectively. Sports injuries accounted for only 10% in contrary to all international studies. D W Lewis reported 58% meniscal injury associated ACL tear at presentation .Medial meniscus was involved more than the lateral meniscus in his study and he also proposed meniscal repair or resection did not alter the outcome and chondral lesions are a better predictor of funtional outcome. Stephen Lyman reported more than 50 % meniscal procedures with ACL reconstructions in 2009.In our study 30% of patients had meniscal injury at presentation and medial meniscus injury predominated lateral meniscus injury like other studies. None of our patients had significant chondral damage at diagnostic arthroscopy.

The graft choice was of great debate in the recent years. Bone patellar tendon bone graft has been gold standard until recent past as

many studies supported patellar tendon graft for its strength and direct bone to bone healing providing early stability. But recent development and advancement in soft tissue fixation devices studies have proven hamstring grafts to be superior in strength and avoiding extensor mechanism disruption. A Harvey[36] in 2005 published histological analysis of soft tissue graft healing by indirect integration producing sharpey fibres between the graft and bone and achieves adequate pullout strength by 12 weeks in animal studies. Aune et al[37] compared the outcomes of patellar tendon and hamstring grafts and reported significantly improved outcome and improved quadriceps function at 6 months follow up but the outcomes equalised with time. Though the outcomes equalised the donor site morbidity was less with hamstring graft. Michael Wagner[38] recommended hamstring graft even in high level atheletes. David D Greenberg[39] proposed allografts has a good alternative of graft but it carries the risk of disease transmission. In our study we used Quadrupled Hamstring graft in all patients which had greatest ultimate load to failure 4140N[36].Thomas D Rosenberg[40] reported patellar chondrosis and anterior knee pain with bone patellar tendon bone graft.

The fixation of the graft has been proved to be the site of failure rather than the graft itself irrespective of the type of graft especially in the early rehabilitation phase when the graft integration has not taken place and the fixation is of little significance after 8 to 12 weeks when graft has integrated with the bone as proposed by Dawn T Gulick[41] .

Various graft fixation devices has been developed in the recent past for soft tissue graft fixation which resulted in the increased reliability on the soft tissue grafts and its use. Steiner et al[42] proposed strong fixation as the key to success in soft tissue grafts. Petterikousa[43] based on in his biomechanical study comparing various fixation devices published that the Bone mulch screw is superior to any other device in providing stiffer fixation of soft tissue grafts and endobutton second only to bone mulch screw. Robert G Marx[44] reported two cases of failure with femoral cross pins. Chae Gwan Kong[45] showed endobutton to be superior than cross pins in femoral fixation. Whereas Young Ho oh[46] showed that a hybrid fixation with a endobutton and a bio screw in femoral tunnel provided adequate stability and stiffness. Andreas Weiler published his results of bioabsorbable round contoured screw to be better than the regular titanium interfernce screws. We used endobuttons as femoral fixation device and titanium interference screw as tibial fixation device. Though

there are concerns about the bungee effect of the graft while using endobutton causing movement of graft in the tunnel, tunnel widening and interference to graft incorporation, a recent study had reported tunnel widening was more with interference screw than the endobutton and attributed tunnel widening to biological factors rather than mechanical factors of the fixation device. In our study there was no pull outs or graft fixation site failures and endobutton was able to withstand the post operative rehabilitation.

In our study we used transtibial or transportal single bundle reconstruction with quadrupled hamstring graft placing the femoral tunnel between 10 30 and 11'o clock position in the right knee and between 1'o clock and 1 30 position in the left knee. John Paul[47] proposed that placing graft at 10 30 position and 1 30 position in single bundle reconstruction reconstructs portions of anteromedial and posterolateral bundles. Masayoshi Yagi[48] showed that anatomic reconstruction allowed better rotatory stability than nonanatomic placements of graft. Asheesh Bedi[49] showed that trans portal placement of tunnel achieved more lateral placement than the trans tibial drilling and trans tibial approach to achieve lateral tunnel placements resulted in over reaming of tibia. Though double bundle reconstructions have gained attraction and studies

have shown double bundle reconstruction to be superior in providing stability in high demand patients. Adachi, Ochi and Uchio[50] showed no significant advantage of double bundle reconstruction than anatomic single bundle reconstruction in factors of stability and proprioception in general population.

The metallic screws distort the knee MRI wherein bioabsorbable screw avoids impairment of imaging. Apart from this metallic screws have to be removed during surgical revision wherein bioabsorbable screws would have been degraded. The major disadvantages are screw breakage at the time of insertion and postoperative inflammatory reaction causing synovitis. We did not come across such problems in our study.

In our study, functional outcome evaluated by Lysholm and Gillquist scoring was nearly equal in both titanium interference screw study group and bioabsorbable interference screw study group and it is statistically insignificiant with P value of 0.97. Our study shows that there is no significant difference in the outcomes associated with the use of titanium and bioabsorbable interference screws used for anterior cruciate ligament reconstruction.

Since our study was a short term follow up we could not comment about the arthritic changes post operatively. Fox et al[51] reported 3 to 17% incidence of anterior knee pain, compared to 13% in our study, Apostolopoulos[52] reported 10% of anterior knee pain. Kurt Spindler[53] stated regular exercise can lead to increased outcomes in 2005.Our patients are put on home based physiotheraphy programe insisting on knee flexion and quadriceps strengthening and mean flexion achieved was 135 degree.J A Grant[54] concluded that home based physiotheraphy is cost effective and not significantly inferior to supervised programmes. As overall conclusion several factors influence the functional outcome in arthroscopic ACL reconstruction. Factors like graft choice, graft fixation, tunnel placement and graft tensioning play a vital role in altering the final outcomes.

CONCLUSION

CONCLUSION

The results of our study were comparable with already published reports of comparative study done using bioabsorsable versus metal interference screws. Our study shows that there is no difference in functional outcome whether bioabsorbable or titanium interference screw was used.

The success of ACL reconstruction depend on the correct technique used for the surgery, precise placement of graft and rehabilitation methods than on type of graft fixation device used, neither titanium nor bioabsorbable screws.

The blunt metal or titanium screw has been the de facto standard in graft fixation. Since the alternate bioabsorbable screw overcomes some of the potential drawbacks, it should become the de facto standard in the future.

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ANNEXURE

PROFORMA

1. Name:
2. Age:
3. Sex:
4. Occupation:
5. Address:
6. I.P No:
7. Presenting H/o:

Side :	L/R
Knee pain	Yes / No
Instability	Yes / No
Swelling	Yes /No
Locking	Yes/No

8. H/o Trauma: Yes / No (If yes – Type of trauma: fall/ RTA / others / Sports).
9. Duration between injury and surgery:
10. Associated medical problems:
11. Clinical Examination Finding:

Ant Drawers –

Post Drawers-

Lachmans-

Effusion-

McMurrays-

Pivot shift-

12. Investigation X-Ray / MRI details:
13. Associated injuries:
14. Type of anesthesia – General / Spinal:
15. Meniscectomy: done / not done
16. Suture removal done on --post-op day
17. Whether brace support used / not used: if used for how many days.
18. Assessment:

- 1st pod
- 1st week
- 2nd week
- 6th week
- 3 months
- 6 months
- 1 year
- 1 & 1/2year

30. Complications:

- Knee effusion yes / no
- Surgical site infection yes / no
- Septic arthritis yes / no
- Fever yes / no
- Implant failure yes / no
- Graft failure yes / no
- Knee stiffness yes / no
- Wound gaping yes / no
- Others

INFORMATION SHEET

We are conducting a study on **"COMPARITIVE ANALYSIS OF FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH QUADRUPLED HAMSTRING TENDON GRAFT FIXED WITH BIOABSORBABLE INTERFERENCE SCREW AND TITANIUM INTERFERENCE SCREW"** among patients attending the Institute of Orthopaedics & Traumatology, Rajiv Gandhi Government General Hospital, Chennai and for that your specimen may be valuable to us.

The purpose of this study is to evaluate and analyse the functional outcome of Arthroscopic ACL reconstruction with quadrupled hamstring tendon graft fixed with bioabsorbable interference screw.

We are selecting certain cases and if you are found eligible, we may be using your radiographs of the knee joint and MRI of the knee jointto evaluate the outcome of surgery which in any way do not affect your final report or management.

The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator | Signature of Participant

Date :
Place :

PATIENT CONSENT FORM

Study Detail	:	**"COMPARITIVE ANALYSIS OF FUNCTIONAL OUTCOME OF ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH QUADRUPLED HAMSTRING TENDON GRAFT FIXED WITH BIOABSORBABLE INTERFERENCE SCREW AND TITANIUM INTERFERENCE SCREW"**
Study Centre	:	Rajiv Gandhi Government General Hospital, Chennai.
Patient's Name	:	
Patient's Age	:	
Identification Number	:	

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ☐

e) I hereby consent to participate in this study. ☐

f) I hereby give permission to undergo detailed clinical examination, Radiographs & blood investigations as required. ☐

Signature/thumb impression	Signature of Investigator
Patient's Name and Address:	Study Investigator's Name: **Dr. AGNIRAJ.R**

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI – 3

EC Reg No. ECR/270/Inst. /TN/2013
Telephone No : 044 25305301
Fax : 044 25363970

Certificate of approval

To

Dr. **R. AGNIRAJ**,

Post- graduate (M.S.Ortho), Institute of orthopaedics and traumatology,
Madras medical college, Chennai-3.

Dear Dr. R. AGNIRAJ.,

The Institutional Ethics Committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled **"Comparative Analysis of Functional Outcome of Arthroscopic Anterior Cruciate Ligament Reconstruction with Quadrupled Hamstring Tendon Graft Fixed with Bio Absorbable Interference Screw and Titanium Interference Screw".** No.28102013.

The following members of Ethics Committee were present in the meeting held on 08.10.2013 conducted at madras medical college, Chennai-3.

1.	Dr. G. Sivakumar, MS FICS FATS	---- Chairperson
2.	Prof. R. Nandini, MD Director, instt. Of Pharmacology, MMC, Ch-3.	---- Member secretary
3.	Prof. Ramadevi, Director i/c, Instt. Of Biochemistry, Chennai	--- Member
4.	Prof. P. karkuzhali, MD Prof. Instt. Of Pathology, MMC, Ch-3.	---- Member
5.	Prof. Kalaiselvi, MD Prof. of Pharmacology, MMC, Ch-3.	---- Member
6.	Thiru. S. Govindasamy, BABL	--- Lawyer
7.	Tmt. Arnold saulina, MA MSW	--- Social scientist

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patient's information / informed consent and asks to be provided a copy of the final report.

20/12/13

Member Secretary. Ethics Committee

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Author	Agniraj R
E-mail	agnikunju2002@yahoo.co.in
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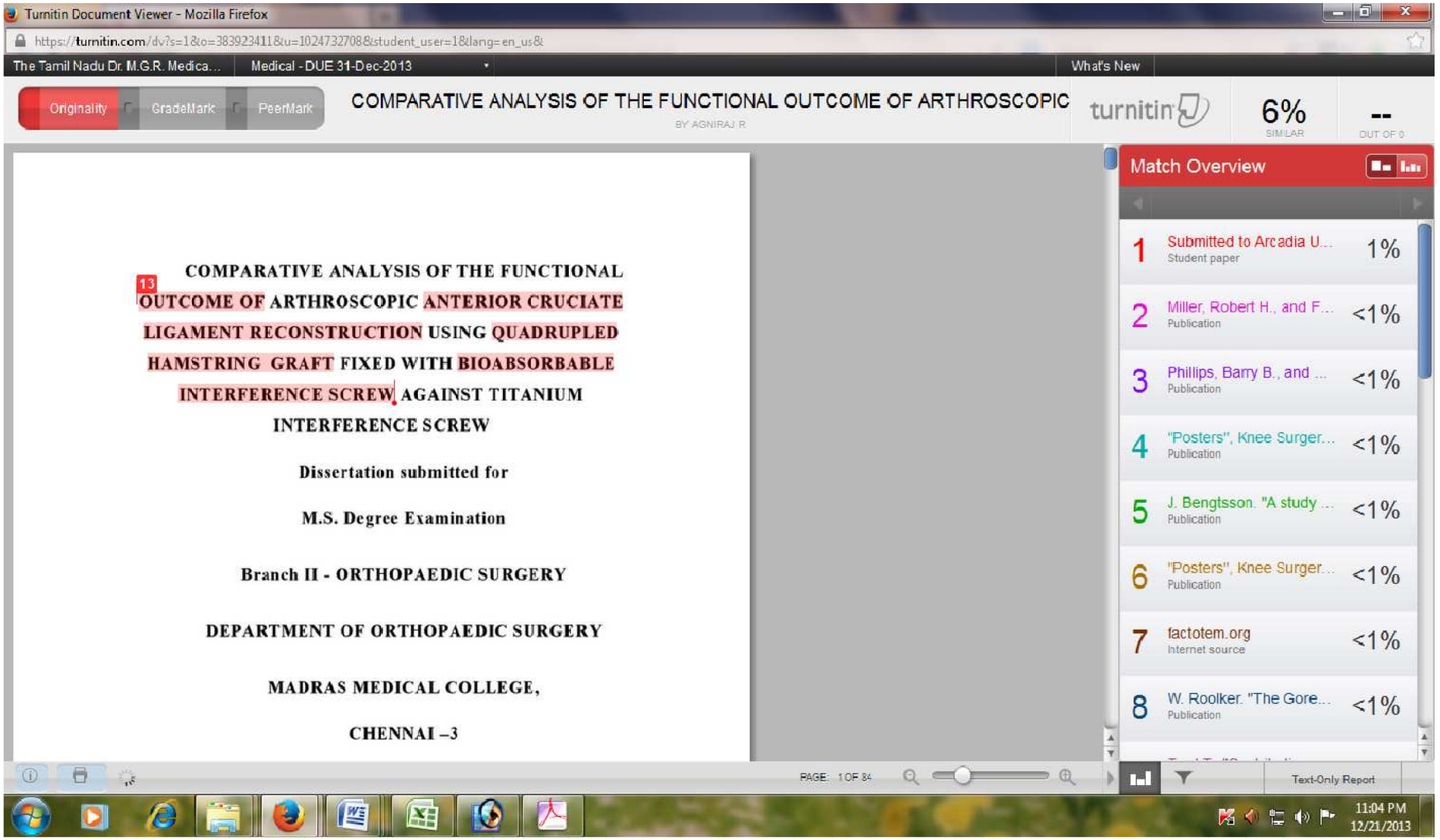
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INTERFERENCE SCREW AGAINST TITANIUM
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Dissertation submitted for
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Branch II - ORTHOPAEDIC SURGERY
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Text-Only Report
11:04 PM
12/21/2013

Sr.no	Name	Age	Sex	Ip no	Diagnosis	Mode of injury	Duration since injury	Screw used	Follow up	LYSHOLM & GILLQUIST SCORE
1	Aravindhan	55	M	46143	Acl tear rt	Fall	5 Weeks	Titanium	18 mon	74
2	Senthil kumar	29	M	46858	Acl tear rt	sports	8weeks	Titanium	16 mon	88
3	Gnanasekar	23	M	53566	Acl with mm tear rt	RTA	5 mon	Titanium	17 mon	94
4	Muthukumar	28	M	56123	Acl tear lt	RTA	9 weeks	Titanium	14 mon	90
5	Venkatesh	32	M	58542	Acl tear rt	Sports	13 mon	Titanium	12 mon	92
6	Dineshkumar	28	M	47844	Acl tear rt	fall	4 weeks	Titanium	10 mon	70
7	Suresh mani	24	M	62468	Acl with mm tear rt	RTA	7 mon	Titanium	11 mon	86
8	Palanimuthu	37	M	60879	Acl with mm tear rt	RTA	10 weeks	Titanium	9 mon	89
9	Mani	24	M	60893	Acl with mm tear rt	RTA	6 mon	Titanium	11 mon	95
10	Bharath	25	M	44307	Acl tear lt	Sports	6 weeks	Titanium	8 mon	68
11	Moorthy	35	M	70644	Acl,mm,lm tear lt	fall	11 weeks	Titanium	13 mon	60
12	Solaimuthu	45	M	60913	Acl tear rt	fall	13 mon	Titanium	9 mon	72
13	Thanikachalam	27	M	72974	Acl tear rt	RTA	15 mon	Titanium	6 mon	84
14	Palanikumar	24	M	75380	Acl tear rt	RTA	8 mon	Titanium	Lost follow up	
15	Yagoop	38	M	80220	Acl tear rt	Fall	5 weeks	Titanium	7 mon	58
16	Marimuthu	28	M	76342	Acl tear lt	RTA	4 mon	Titanium	8 mon	100
17	Dhanasekar	42	M	84136	Acl tear lt	Fall	8 mon	Titanium	11 mon	90
18	Veerapandi	44	M	89871	Acl tear rt	fall	9 mon	Titanium	6 mon	88
19	Hussain	25	M	92475	Acl ,mm tear lt	sports	6 mon	Titanium	12 mon	91

20	Poongavanam	26	F	108669	Acl,mm tear lt	Fall	4 weeks	Titanium	7 mon	94
21	Kumar	32	M	102029	Acl tear rt	sports	14 mon	Titanium	8 mon	100
22	Dhanasekar	48	M	109660	Acl,mmtear lt	RTA	10 weeks	Titanium	10 mon	83
23	Suresh	34	M	112142	Acl tear rt	RTA	5 mon	Titanium	9 mon	88
24	Karthick	24	M	112202	Acl tear rt	Sports	11 mon	Titanium	7 mon	90
25	Murali	42	M	1904	Acltear rt	RTA	6 weeks	Titanium	10 mon	86
26	Ramsekar	40	M	117543	Acl tear lt	Fall	10 mon	Titanium	Lost follow up	
27	Balaji	28	M	8710	Acl tear lt	fall	4 mon	Titanium	10 mon	88
28	Paul renald	29	m	11244	Acl tear rt	RTA	14 mon	Titanium	9 mon	91
29	Venkateshkumar	31	M	55339	Acl tear lt	Fall	10 mon	Titanium	6 mon	89
30	Gunavathy	45	F	1170	Acl,lm tear lt	RTA	8 mon	Titanium	11 mon	95
31	Rajesh	25	M	1938	Acl tear rt	Sports	5 weeks	Bio-abs	14mon	94
32	Shankar	26	M	1125	Acl tear rt	fall	5 mon	Bio-abs	10 mon	88
33	Ashok kumar	43	M	9112	Acl tear rt	RTA	15 mon	Bio-abs	16 mon	98
34	Velu	37	M	1137	Acl,mm tr rt	RTA	12 weeks	Bioabs	8 mon	94
35	Nithish guna	28	M	4238	Acl tear lt	RTA	6 mon	Bio-abs	9 mon	86
36	Dhanam	49	M	18289	Acl tear rt	fall	13 mon	Bio-abs	11 mon	56
37	Suryabanu	20	F	20611	Acl tear rt	fall	5 mon	Bio-abs	12 mon	90
38	Amjith	22	M	34157	Acl tear rt	Sports	6 weeks	Bio-bs	7 mon	86

39	Sukumar	33	M	50978	Acl,mm tear rt	RTA	7 mon	Bio-abs	6 mon	72
40	Saranraj	20	M	23184	Acl tear lt	RTA	8 weeks	Bio-abs	6 mon	96
41	Saravanan	20	M	23184	ACL TEAR LT	RTA	4 mon	Bio-abs	8 mon	88
42	Abdul	28	M	53200	Acl,mm tear rt	RTA	9 mon	Bio-abs	9 mon	68
43	Punitha	38	F	53614	Acl tear lt	fall	5 mon	Bio-abs	11 mon	90
44	Devendran	43	M	58217	Acl,lm tear rt	fall	10 mon	Bio-abs	8 mon	76
45	Anand	22	M	58169	Acl tear rt	sports	3 mon	Bio-abs	9 mon	100
46	Damodaran	24	M	50244	Acl tear lt	RTA	5 weeks	Bio-abs	7 mon	94
47	Ranjithkumar	24	M	66054	Acl,mm tear lt	RTA	9 weeks	Bio-abs	15 mon	86
48	Muniyamma	35	F	63106	Acl tear rt	fall	5 mon	Bio-abs	8 mon	84
49	Siva	21	M	71927	Acl,mm tear lt	RTA	10 weeks	Bio-abs	6 mon	90
50	Srinivasan	38	M	72870	Acl tear rt	fall	14 mon	Bio-abs	6 mon	92
51	Indhumathi	35	F	75229	Acl tear rt	RTA	6 mon	Bio-abs	6 mon	95
52	Kavitha	28	F	63164	Acl tear lt	fall	15 mon	Bio-abs	6 mon	54
53	Munee sheriff	26	M	77904	Acl,lm tear rt	RTA	8 mon	Bio-abs	9 mon	88
54	Balamurugan	25	M	3482	Acl tear rt	sports	4 weeks	Bio-abs	11 mon	86
55	Kumar	32	M	78992	Acl,lm,mm tear rt	RTA	11 weeks	Bio-abs	6 mon	84
56	Nagamani	35	F	75227	Acl tear lt	fall	9 mon	Bio-abs	8 mon	92
57	Sankarappa	28	M	87647	Acl,mm tear rt	RTA	6 weeks	Bio-abs	7 mon	96
58	Rajesh	26	M	80215	Acl tear rt	RTA	7 mon	Bio-abs	6 mon	89
59	Muthulakshmi	26	F	90167	Acl tear rt	fall	4 mon	Bio-abs	8 mon	86
60	Padmanaban	33	M	92774	Acl tear rt	fall	5 weeks	Bioabs	6 mon	90